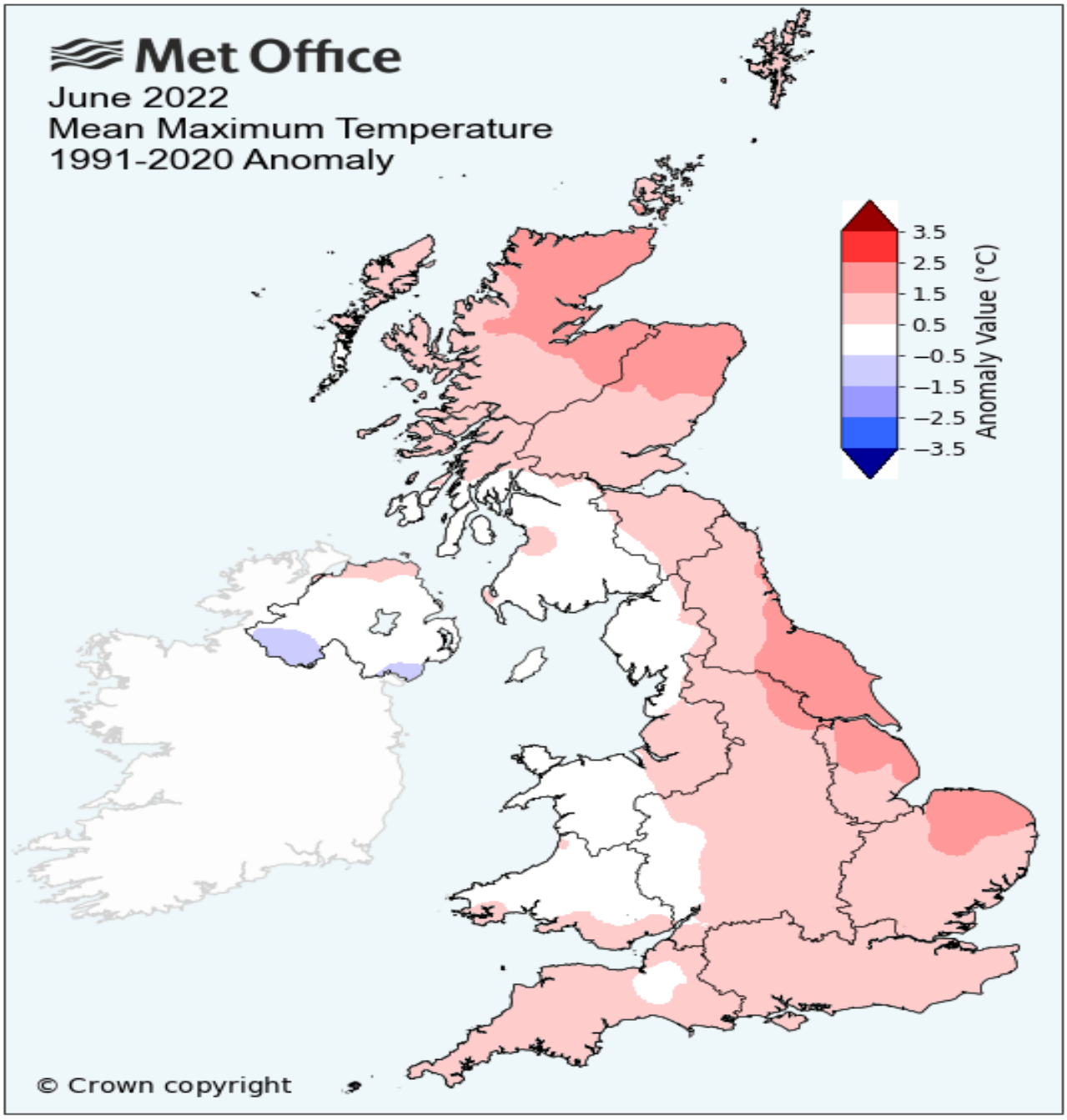
June extends run of warm months

Description

As we reach the half-way point of 2022, June continued the run of each month so far this year reporting above-average temperatures, as warm and dry conditions reigned for much of the month.

According to provisional Met Office figures, June 2022's average mean temperature* for the UK was 13.9°C, which was 0.6°C above the long-term average (1991-2020). Maximum temperatures were also above average for the month, with 18.6°C the average daily high, some 0.9°C above the long-term figure. This was spurred on by a warm spell in the middle of the month, when temperatures peaked at 32.7°C on 17 June at Heathrow Airport and Santon Downham, in Suffolk. Daily minimum temperatures were somewhat closer to average for many.

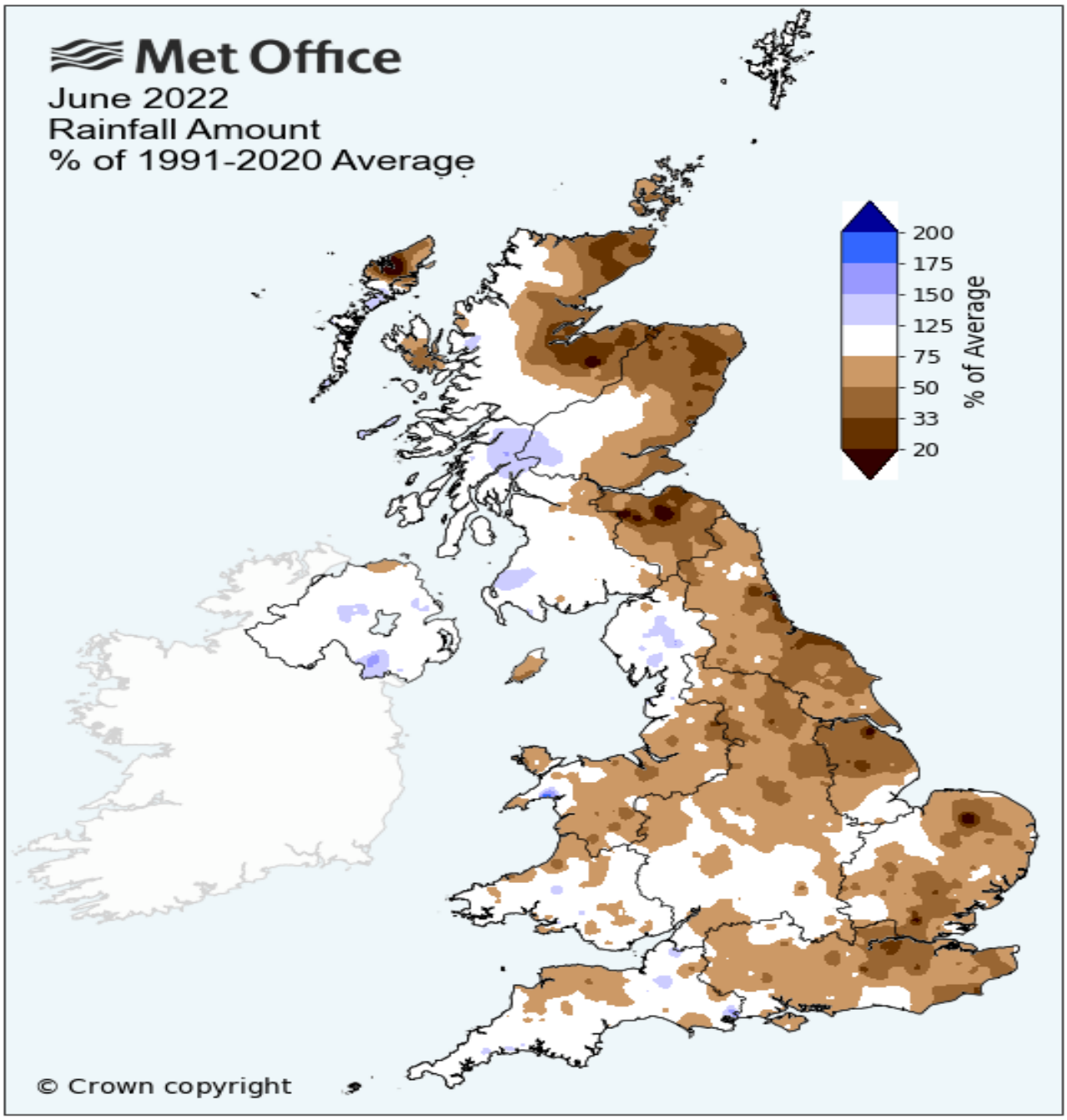
However, June's heat wasn't spread evenly across the UK, with the highest departures from average along eastern coasts of England and Scotland. England and Scotland both saw average maximum temperatures 1°C more than their long-term averages, at 20°C and 16.6°C respectively, while Wales and Northern Ireland were much closer to their averages, with 18°C and 17.1°C respectively.



Mean temperature for the UK in June against the long-term average

Dry, but not for everyone

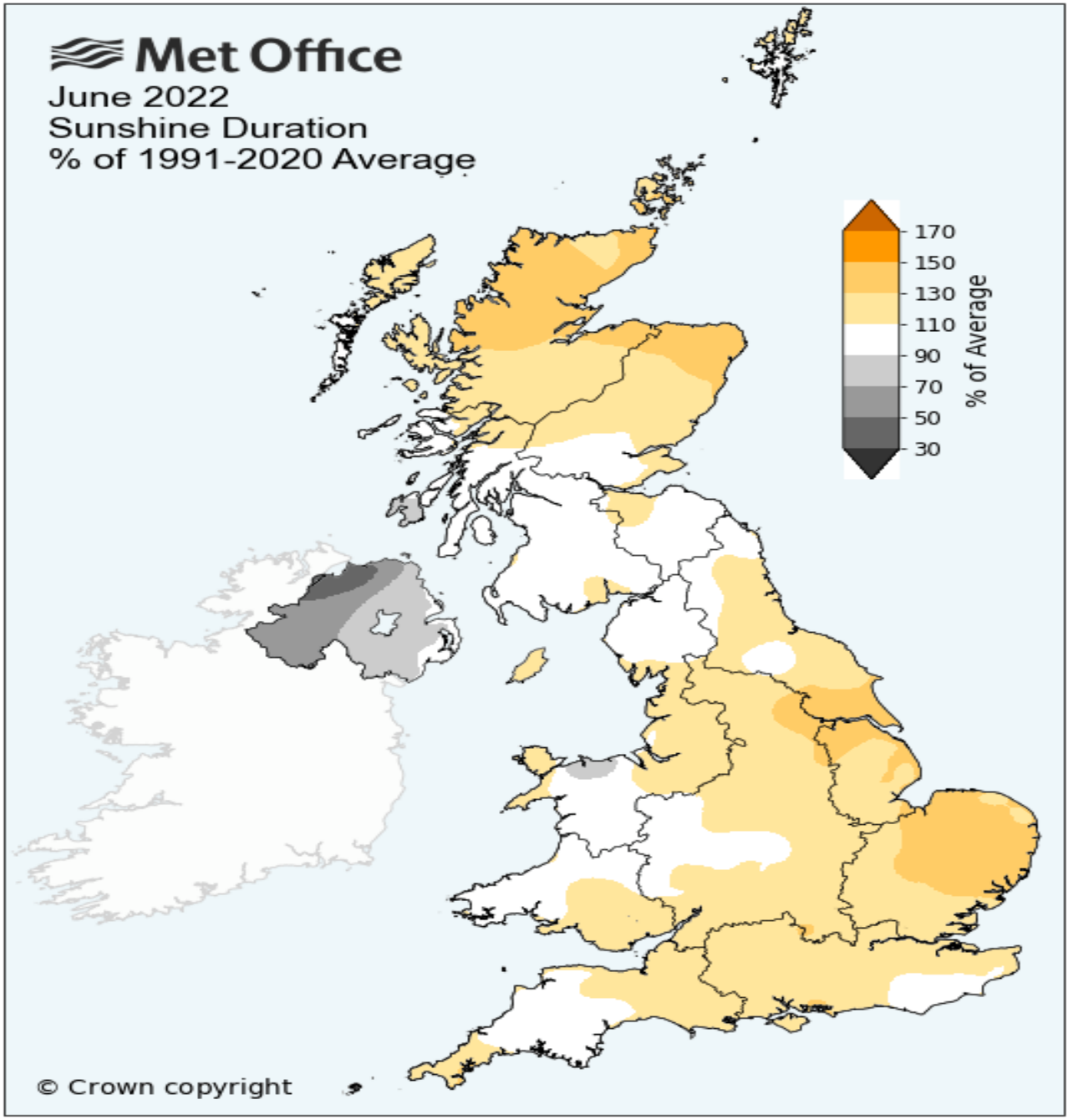
Despite some periods of late-month rainfall for much of the UK, figures are still around a quarter below their average for the month. For the UK, an average of 59mm of rain fell in the month, which is 24% less than the long-term average. Areas in England and eastern Scotland were particularly dry, although not enough to trouble any records. However, Northern Ireland did breach its long-term average figure, with 84.7mm of rain being 4% more than their average, thanks largely to some bursts of rain late in the month.



Rainfall amount for the UK against the long-term average

Sun shines for most

Sunshine figures for the month were largely above average, with an average of 195.8 sunshine hours in the UK, which is 14% more than the long-term average for June. However, as with temperature and rainfall, the sunniest conditions were in the east meaning Northern Ireland was the main exception with just 108.1 hours of sunshine – which is 28% less than the long-term average.



Sunshine duration for June 2022 against the long-term average

Dr Mark McCarthy of the National Climate Information Centre said: “Looking at the weather and climate

figures for June 2022, it has been a fairly unremarkable month, albeit with a particularly warm spell in the middle of the month and a fairly dry and sunny month for most.

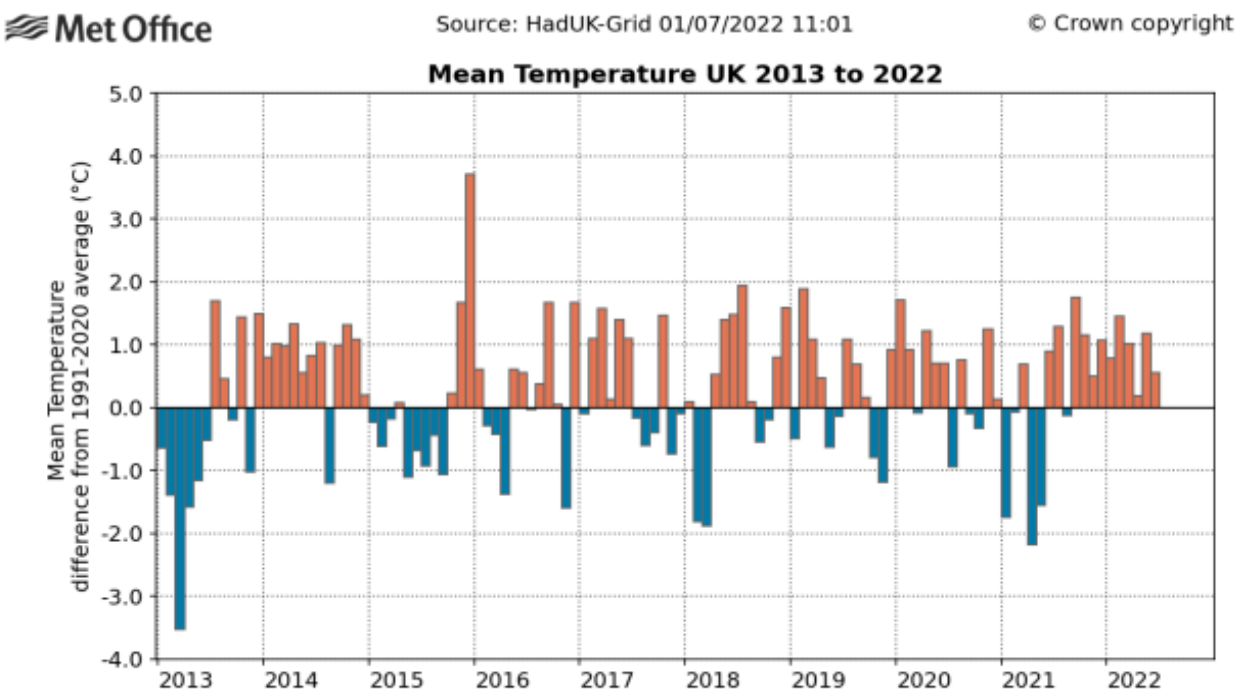
“With the warmest, driest and sunniest weather to be found in the east, Northern Ireland was the outlier for a few of the statistics, with a few interludes of cloud and rain meaning there has been a relatively dull month, with sunshine in short supply in the west of Northern Ireland.”

Provisional June 2022	Mean temp (°C)		Sunshine (hours)		Rainfall (mm)	
	Actual	Diff from avg (°C)	Actual	% of avg	Actual	% of avg
UK	13.9	0.6	195.8	114	59	76
England	14.9	0.5	220.9	118	45	69
Wales	13.5	0	190.7	107	71.5	78
Scotland	12.5	0.8	170.2	116	74.7	80
N Ireland	13.4	0.4	108.1	72	84.7	104

Climate change

With June proving to be warmer than average according to mean temperature, 2022 continues a run of months since September 2021 being warmer than average, that’s despite a change to a new meteorological averaging period which reflects the UK’s changing climate as a result of human-induced climate change. Even with this recent shift in the averaging period, which demonstrated an increase in average UK temperature of 0.8°C compared to an earlier 1961-1990 period, 2022 has so far been higher than the average for every month, as well as the closing three months of 2021, even when measured against the latest averages.

Mark continued: “It’s perhaps noteworthy that 2022 so far hasn’t had any month report below-average mean temperature. Of course, short-term weather will always lead the direction of monthly statistics, but even with the change in averaging periods to reflect our changing climate, 2022 has had a run of relatively mild or warm weather, meaning that the January-June period for 2022 has been in the top five warmest for the UK in a series from 1884. This doesn’t mean that cooler months won’t still occur, such is the natural variability of the UK climate, but a warming trend for the UK over a longer period is consistent with what we’ve seen in our climate figures.”



The graph shows mean temperature for each month in the UK back to 2013. This is measured against the latest averaging period (1991-2020), with the red bars denoting a month with above average mean temperature, and the blue below average.

*Mean temperature is calculated by the difference between the average daily maximum and average daily minimum temperature.

Date Created
July 2022

Crowdsourcing for weather & climate monitoring

Description

Observations constitute our primary source of information about how our climate is changing. They provide direct and unequivocal evidence of the impacts of climate change, are indispensable for the development of seasonal climate predictions, and are essential for validating and improving the models used to simulate future climates under different emission scenarios.

The Met Office operates many of its own observing networks, whilst also participating in global partnerships such as the Global Climate Observing System (GCOS) to facilitate the sharing of global climate observations. Various climate variables are collected from different observing systems, quality checked, and brought together to obtain the best possible description of the climate. Alongside long-term climate monitoring – which you can see visualisations of in our climate dashboard – we also need high-quality observations to support the attribution and prediction of climate change-induced extreme weather events.

Wind observations equipment. Image: Crown Copyright

The urban environment

Globally, urban areas constitute one of the most significant challenges in current observational

capability. The importance of this challenge cannot be understated – across the world an ever-increasing number of people live and work in urban areas and will be particularly vulnerable to the impacts of climate change and heat stress. In the UK, heat-related mortality is projected to increase under a medium emissions scenario by around 257% by the 2050s, with this figure even greater in London[1].

Met Office Foundation Scientist, Matthew Fry explains, “At the heart of this lies the fact that city environments aren’t typically compatible with the requirements we follow when siting our observation networks. Obstructions from buildings are rife, and there’s tarmac everywhere! Despite these challenges, we need observations to help us understand the complexities of the urban environment; develop and improve our urban-scale modelling capability, and to monitor changes over time.”

The growth of crowdsourced observations

In recent years, the advent of the ‘smart home’ has brought the capability for weather observations into the homes and gardens of a greater number of individuals. Alongside this, a plethora of internet-connected devices now have the capability to make and share meteorological observations, at spatial densities that would be simply impossible via conventional means.

Developing novel crowdsourcing methods is a highly active area of research. Some remarkable examples include deriving air temperature measurements from smartphone battery temperatures, and even detecting UK flood events using Twitter! Alongside these indirect crowdsourcing methods, there exists a wide variety of dedicated observational networks comprised of citizen-owned and operated devices. Companies such as Netatmo, Davis, and Oregon Scientific offer home weather stations and associated apps/websites that allow users to record their own observations and view those of others on online weather maps.

In 2011, the Met Office launched its own platform – the Weather Observations Website (WOW) – designed to enable the sharing of current weather observations from all around the globe, regardless of their level of detail or frequency. Observations might come from specially designed digital, scientific, or wireless weather stations, or alternatively from simply looking out of the window and recording the present weather situation. In 2020, WOW passed the remarkable milestone of 1.5 billion total observations and routinely receives over 25 million observations a month.

As well as being a great tool for public engagement, data from WOW have been used in operational applications. Following the development of quality control and bias-correction methods, data from WOW have been used in nowcasting applications, demonstrating particular use during severe rainfall events. Archived WOW observations have also proven useful in the detection of drought episodes in the Netherlands and urban climate research in Berlin.

How can I get involved?

Climate change is already affecting every inhabited region of the globe, with human influence contributing to an increased frequency and intensity of extreme weather events. Every observation is critical in monitoring and attributing these changes, with particular value provided by observations from data sparse regions.

The Met Office WOW platform is a free resource, with observations submitted there having genuine applications in both weather and climate science. If you have your own weather station you can register and upload data automatically to WOW, or alternatively you get involved by recording your own photos, observations, or weather impacts via the website.

Sources

[1] Hajat S, Vardoulakis S, Heaviside C, Eggen B. (2014). Climate change effects on human health: projections of temperature-related mortality for the UK during the 2020s, 2050s and 2080s. *J Epidemiol Community Health*. **68**(7):641-8. doi: 10.1136/jech-2013-202449.

Date Created
July 2022

It’s warmer than average. But what is average?

Description

This month we have been exploring the topic of climate monitoring, and in this post we hear from the World Meteorological Organization (WMO) about its role in global monitoring and its value for decision making.

World Meteorological Organization (WMO) logo

The heat of summer is upon us, and there is much talk about how it is warmer than average – certainly in many parts of Europe. But what is average?

Well. It’s complicated. And this is why we need global coordination and support.

The World Meteorological Organization helps monitor the Earth’s climate on a global scale to provide the best possible science to support decision-making.

In order to assess whether a given day, week, month or year is warmer or wetter than average, we use a 30-year baseline, known as ‘Climatalogical Standard Normals’. These are averages of climatological data over a 30-year period, 1 January 1981–31 December 2010, 1 January 1991–31 December 2020, and so forth. It’s important to use a long-term average because of the natural variability in our climate.

Rising atmospheric concentrations of greenhouse gases are changing the Earth’s climate much faster than before, and therefore WMO has agreed that the standard 30-year reference period has to be updated every decade in order to better reflect the changing climate and its influence on our day-to-day weather experience.

This is vital for operational decision-making in climate-sensitive sectors and industries such as water management, energy, agriculture and viticulture (production of grapes). They need up-to-date information for forecasting of peak energy load, crop selection and planting times, transport planning and schedules, and much more.

A new baseline

Until the end of 2020, the most current and widely used standard reference period for calculating climate normals was the 30-year period 1981-2010. WMO's recent Executive Council recommended that the new 30-year baseline, 1991-2020, should be adopted globally and pledged support to Members to help them update their figures.

The United States of America and many countries in Europe have already switched to the new baseline, aided by today's increasingly powerful computers and climate data management systems making it much easier to conduct more frequent updates, which involve analysing massive amounts of climate data.

But for developing countries, which have significant gaps in their data collection and processing capacity, this poses a real challenge. Just 70 out of 193 Members submitted their Climate Normals (CLINO) for the period 1991–2020 – less than 37%. This raises the concern of meeting the deadline for completing the CLINO collection in 2023.

"Missing CLINO 1991–2020 will seriously hamper the quality of Members' and WMO products and services. Operational monitoring and prediction products, such as El Niño/La Niña monitoring, State of Climate reports, seasonal forecasts etc. will suffer from a non-delivery of updated CLINO. These products will lose their modern relevance for various application sectors as a result of the changing climate," comments Omar Baddour, Head of WMO Climate Monitoring and Policy Division.

"An urgent collective action involving Members, WMO Secretariat, Technical Commissions and Regional Associations is needed to accelerate Members' data submission and collection," he says.

Ian Lisk from the Met Office and president of the WMO Services Commission agrees. "The Climate Normals dataset is used for a wide range of applications all over the world. It is also worth highlighting that there are also fixed historical reference periods that are used to benchmark climate change monitoring. The WMO Reference Period for long-term climate change assessment is based on the period 1961-1990 whilst the pre-industrial reference period, 1850-1900, is used by WMO and IPCC as the baseline for estimating past and future global temperature increases."

He goes on to add that, "The WMO Services Commission is currently developing guidance on good practices for the use of climate normals and other reference period baselines to support the improved communication of climate change related information.''

Consolidated data

WMO uses six international datasets for temperatures – HadCRUT.5.0.1.0 (Met Office, UK), NOAAGlobalTemp v5 (USA), NASA GISTEMP v4 (USA), Berkeley Earth (USA), ERA5 (ECMWF) and JRA-55 (Japan).

In 2021, the Met Office and the University of East Anglia upgraded their long-running HadCRUT dataset, including better coverage in data-sparse areas such as the rapidly warming Arctic.
This provides more accurate estimates of global, hemispheric and regional temperature changes. The previous version, HadCRUT4, showed less warming than other global temperature data sets.

HadCRUT5 is now more consistent with these other datasets during recent decades and shows slightly more warming than most of them do over the full period since 1850.

Thus, the average global temperature in 2021 was about 1.11°C (± 0.13) above the pre-industrial level. The warmest year on record remains 2016, when the average global temperature was 1.29°C above the pre-industrial era because of a combination of a powerful El Niño event and global warming.

With each passing year, the chance of us reaching the 1.5°C lower limit of the Paris Agreement increases. Continued climate monitoring is therefore vital to inform mitigation policy and to guide us in our efforts to adapt to climate change.

Date Created
July 2022

Maximum temperatures and how they’re recorded

Description

Here at the Met Office we have been collecting weather observations since we were founded, and the earliest daily temperature data we have in our digital climate database is from 1853. However, there are a number of elements to verify temperatures and any associated records which ensure a fair comparison and consistency across our annals.

How are temperatures measured?

Since the 1960s, temperatures quoted by the Met Office have had to come from stations that meet specific criteria and are regularly maintained and inspected by our specialist teams. Only data that is measured to the nearest decimal point are included, meaning that observations from certain stations that measure to whole numbers, such as METAR stations at airports, can’t be used in these standardised results.

Within these stations, thermometers have to be housed in a white slatted box with its door facing north, called a Stevenson screen, which keeps the thermometer away from direct sunlight but air flow constant.

Consistency in the locations of these boxes is also crucial, mounted 1.25m high over level, grassy ground. Man-made materials such as concrete can have a large impact on results through properties such as heat retention, and due to this the Stevenson screens should be located at least 20m away from concrete or hard standing, and only half of the area within a 100m radius should be formed of man made surfaces.

Stevenson Screen. Image: Met Office

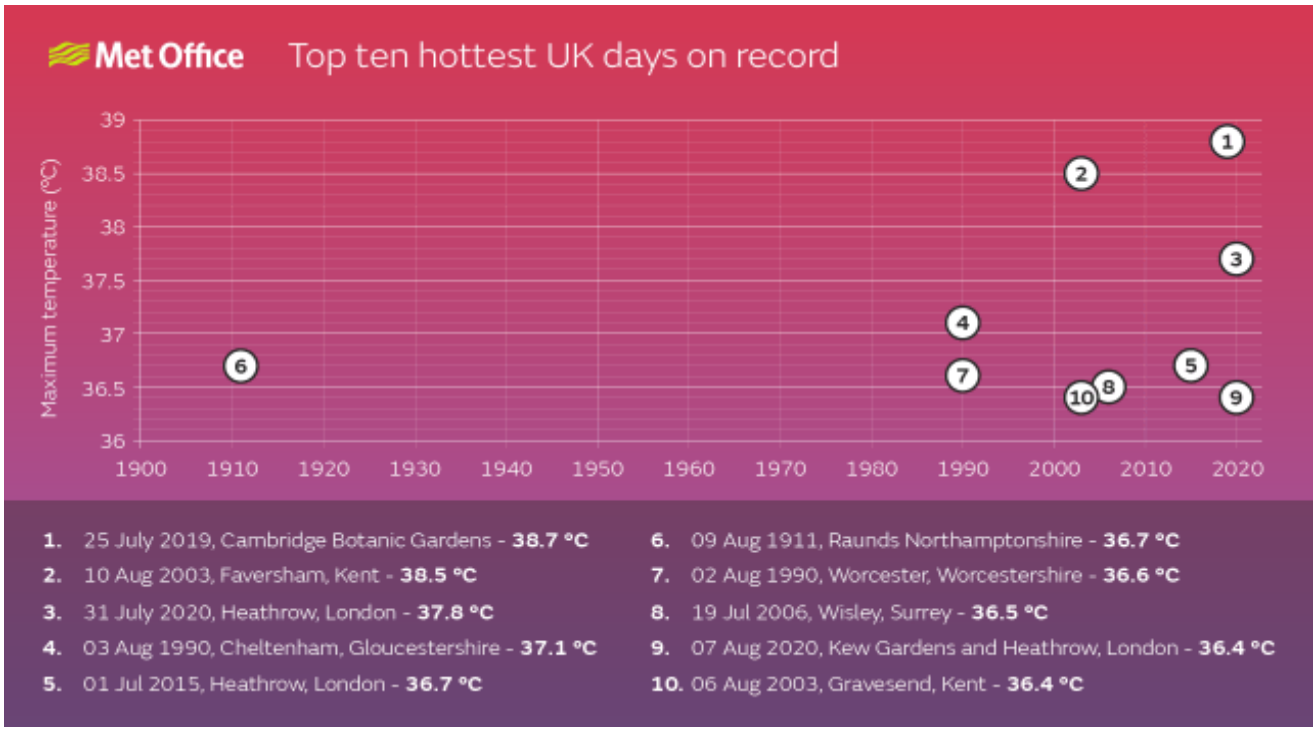
When are maximum temperatures officially recognised as a new record?

There is a verification process to the daily real time data which has to go through quality control prior to it's release, such as cross referencing with nearby stations for any inconsistencies. However, for records to become official more rigorous quality control is carried out over a longer period of time, potentially several months, before they can be recognised as a new record. These include wider cross checking between stations and sites, understanding of the weather on the day and what was expected compared to our forecasts.

Additional to these validations, physical inspections by a team of engineers mean they can check that equipment is working as it should with no anomalies, adding an additional layer of verification to ensure reported records are correct.

What are we learning from the past?

There have been significant impacts from high temperatures over the past century, with many lessons learnt to minimise these effects. In 1911 when temperatures reached 36.7°C, around 4,000 people died in London alone during the heatwave period. Droughts impacted water supplies, lack of grazing for cattle increased milk prices, and certain outdoor employers had to adjust the working hours of their staff in order to avoid the heat.



Graph showing how nine of the top 10 hottest UK days have been since 1990. Image: Met Office

The trend for these high temperatures has also been increasing, with nine of the ten hottest days on record in the UK falling from 1990, three of these since 2019. However, technology has developed, and whilst these temperatures still pose a significant risk to life, the ability to forecast more nearly a week ahead allows people to prepare and adapt their actions to try and minimise the effects that heat can bring.

Date Created
July 2022

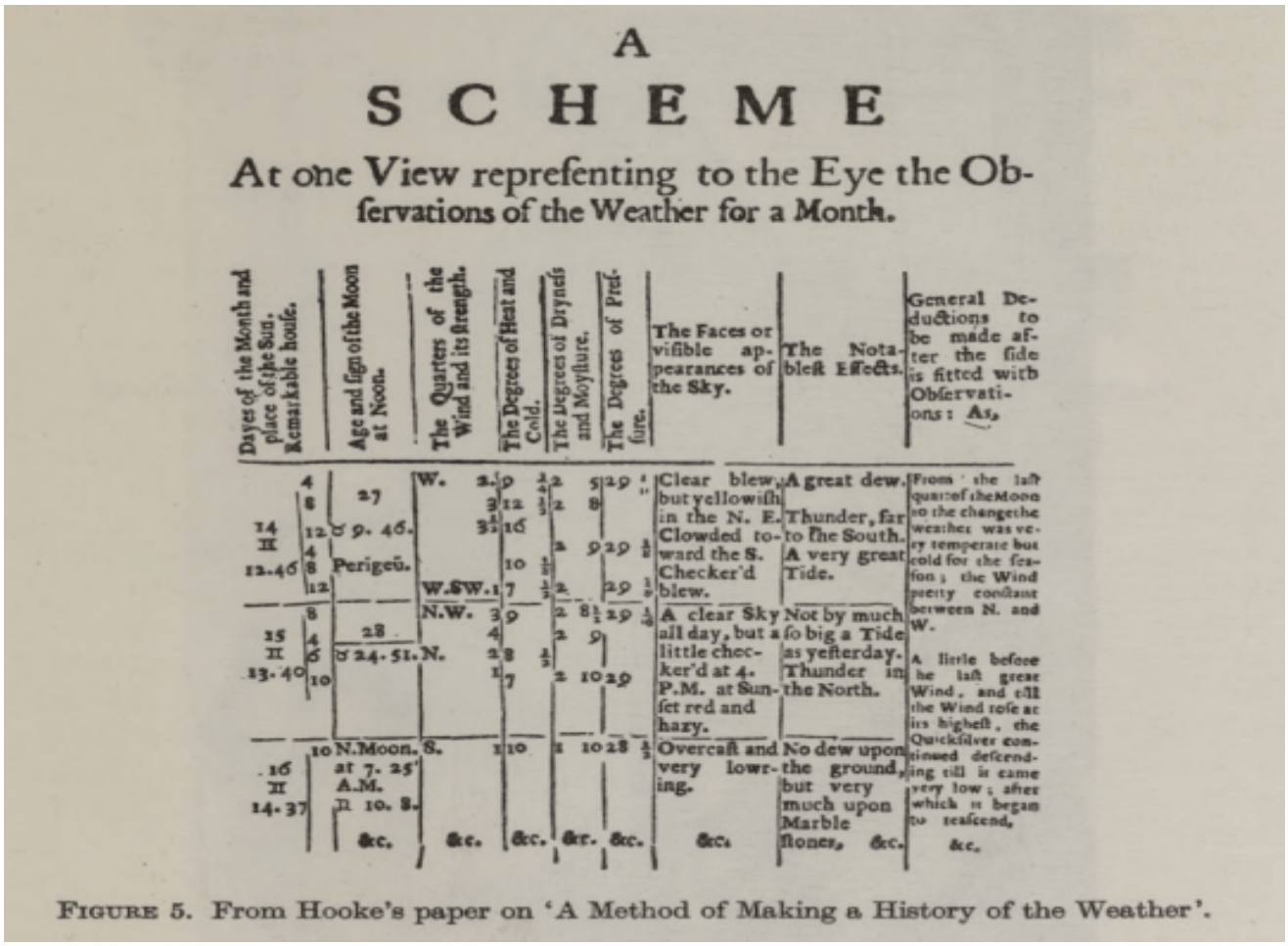
Climate monitoring through historical data

Description

It is mid July 2022. We are currently experiencing a significant – at the time of writing provisionally record-breaking – heatwave for the UK. Red weather warnings for extreme heat are in force for large parts of England and forecasts indicated a real possibility of temperatures reaching up to 40°C in some areas. Indeed, this temperature has already been exceeded. Whether or not records are broken, a key part of the work that we do at the Met Office is climate monitoring, an important aspect of which is the ability to put current weather into historical context. Climate monitoring serves many functions: It can effectively communicate the relative severity of an event; it can indicate how frequently such extremes are likely to occur; and it can monitor how the character or frequency of extremes are changing over time. In order to properly understand the risks from climate change, a key research question climate monitoring can help us to answer is, 'What are the current weather and climate hazards, risks and impacts that should be expected in the UK and globally?'. To address this question, we must look to the past, and the scientific effort goes back further than you might think.

Making history

In 1663, Robert Hooke stood before the relatively newly formed Royal Society and proposed *'A method for making the history of the weather'.* Hooke and other notable scientists of the time were actively developing instruments capable of making meteorological measurements of wind, rain, air pressure, humidity and temperature. These were the early anemometers, rain gauges, barometers and thermometers of the time[1]. In his paper, Hooke recommended what should be measured and how it should be recorded, including '*a scheme at one view representing to the eye the observations of the weather for a month*' and implored his colleagues to undertake such measurements. From a modern climatologist's point of view, arguably one of the most important advances by Hooke was his recognition that if systematic and consistent measurements were made across the country, or even across the world, then an international perspective on the weather could be obtained, for the benefit of humankind.



A

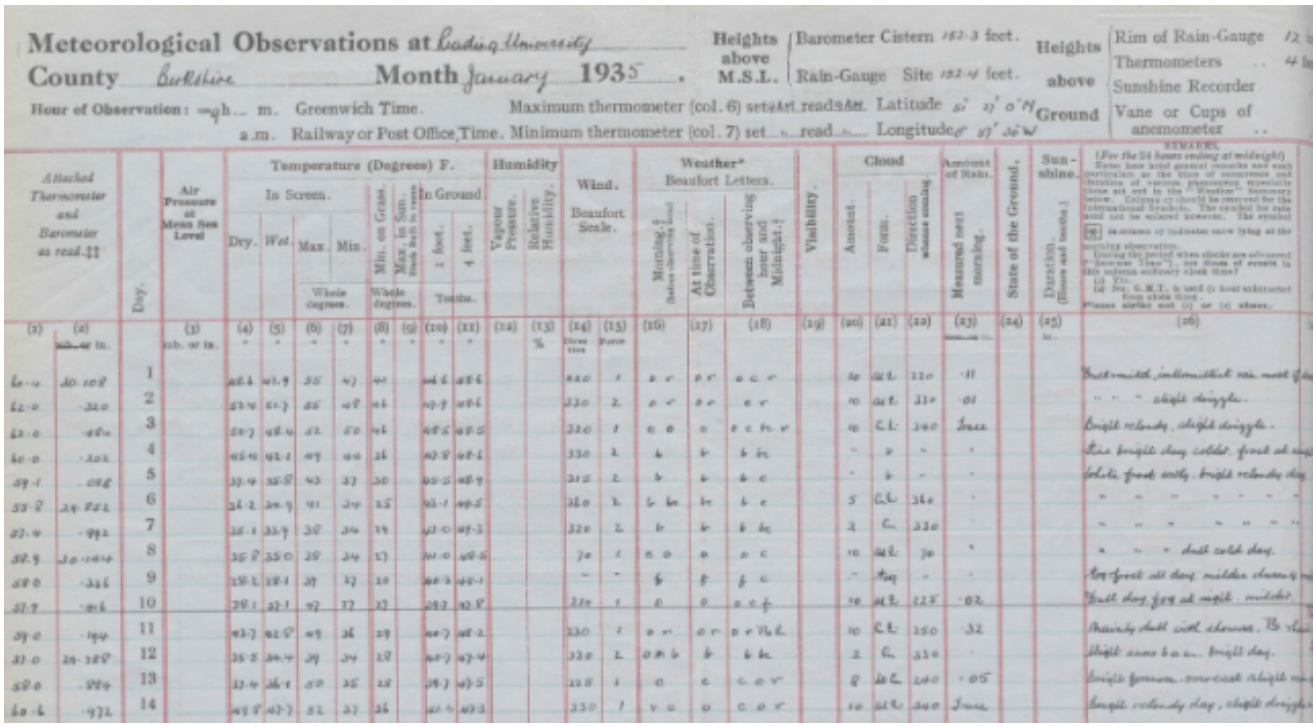
SCHEME

At one View repreſenting to the Eye the Obſervations of the Weather for a Month.

Dayes of the Month and place of the Sun. Remarkable houſe.	Age and ſign of the Moon at Noon.	The Quarters of the Wind and its ſtrength.	The Degrees of Heat and Cold.	The Degrees of Dryneſs and Moyſture.	The Degrees of Preſſure.	The Faces or viſible appearances of the Sky.	The Notableſt Effects.	General Deductions to be made after the ſide is fitted with Obſervations: As,
4 8 12	27	W.	9 12 16 10 7	2 2 2 2	29 29 29	Clear blew, but yellowiſh in the N. E. Clowded toward the S. Checker'd blew.	A great dew. Thunder, far to the South. A very great Tide.	From the laſt quarter the Moon to the change the weather was very temperate but cold for the ſeaſon; the Wind pretty conſtant between N. and W.
14 ♊ 12.46	☌ 9. 46. Perigeũ.	W.SW.						
8 4 8 12	28	N.W. N.	9 4 8 1	2 2 2	29 29 1029	A clear Sky all day, but a little checker'd at 4. P.M. at Sunſet red and hazy.	Not by much ſo big a Tide as yeſterday. Thunder in the North.	A little before the laſt great Wind, and till the Wind roſe at its higheſt, the Quickſilver continued deſcending till it came very low; after which it began to aſcend,
15 ♊ 13. 40	☌ 24. 51.							
10 16 ♊ 14. 37	N. Moon. at 7. 25' A.M. ♎ 10. 8.	S.	10	1	1028	Overcaſt and very lowring.	No dew upon the ground, but very much upon Marble ſtones,	
&c.	&c.	&c.	&c.	&c.	&c.	&c.	&c.	&c.

FIGURE 5. From Hooke's paper on 'A Method of Making a History of the Weather'.

Image reproduced from the Royal Society Wilkins Lecture (1950):
https://royalsocietypublishing.org/doi/pdf/10.1098/rspa.1950.0071



Meteorological Observations at Reading University

County Berkshire Month January 1935

Heights above M.S.L. | Barometer Cistern 152·3 feet. Rain-Gauge Site 152·4 feet. | Heights above Ground | Rim of Rain-Gauge 12 ft. Thermometers .. 4 ft. Sunshine Recorder Vane or Cups of anemometer ..

Hour of Observation: 9h .. m. Greenwich Time. Maximum thermometer (col. 6) set and read 9 AM. Latitude 51° 27' 0"N
a.m. Railway or Post Office Time. Minimum thermometer (col. 7) set .. read .. Longitude 0° 57' 36"W

Attached Thermometer and Barometer as read	Day.	Air Pressure at Mean Sea Level	Temperature (Degrees) F. In Screen. Dry.	Wet.	Max.	Min.	Min. on Grass.	Max. in Sun. Black Bulb in vacuo	In Ground. 1 foot.	4 feet.	Humidity. Vapour Pressure.	Relative Humidity.	Wind. Beaufort Scale.	Weather* Beaufort Letters. Morning	At time of Observation.	Between observing hour and Midnight.	Visibility.	Cloud. Amount.	Form.	Direction whence coming	Amount of Rain. Measured next morning.	State of the Ground.	Sunshine. Duration.	REMARKS. (For the 24 hours ending at midnight)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
	inches	mb. or in.	°	°	Whole degrees.		Whole degrees.		Tenths.			%	Beaufort Scale	Force											
6·4	30·108	1	46·6	43·9	55	47	41		44·6	48·6			220	1	e c	0 c	e c c		10	St.	220	·11			Fresh mild, intermittent rain most of day
6·0	·320	2	51·4	47·3	65	48	46		47·3	48·6			330	2	e c	0 c	e c		10	St.	310	·01			" " " slight showers.
6·0	·480	3	50·7	48·4	52	50	46		48·6	48·5			220	1	c 0	0	c c Fr. c		10	C.L.	240	Trace			Bright cloudy, slight showers.
6·0	·321	4	45·4	43·1	49	40	36		47·8	48·4			330	2	b	b	b b		-	b	-	-			Fine bright day, cold. frost at night
5·9	·082	5	33·4	32·8	43	33	30		46·6	48·4			212	2	b	b	b c		-	b	-	-			Sharp frost early, bright cloudy day
5·8	29·872	6	34·2	30·9	41	30	25		46·1	48·5			210	2	b bn	bc	b c		5	C.L.	360	-			" " " " " " " "
5·4	·992	7	35·1	33·9	38	30	29		45·0	48·3			220	2	b	b	b bc		2	C.	330	-			" " " " " " " "
5·2	30·004	8	35·8	35·0	38	34	27		44·0	48·5			70	1	c 0	0	0 c		10	St.	70	-			" " " dull cold day.
5·0	·326	9	38·2	38·1	39	37	30		46·5	48·1			-	-	b	b	b c		-	Fog	-	-			Foggy frost all day, milder showers at night
5·2	·416	10	39·1	38·1	42	37	37		48·2	48·8			220	1	0	0	0 c b		10	St.	225	·02			Dull day, fog at night. milder.
5·0	·194	11	42·7	42·8	49	36	29		46·7	48·2			330	1	e r	0 r	e r Th L		10	C.L.	250	·32			Mainly dull with showers. Th
5·0	29·889	12	35·5	34·4	39	34	32		46·7	47·4			330	2	0 M b	b	b bc		2	C.	330	-			Slight snow b a.m. bright day.
5·0	·889	13	37·4	36·1	50	35	28		48·3	48·5			220	1	c	c	c c r		8	St C.	240	·05			Bright forenoon, snow-cast slight showers
6·6	·972	14	43·8	42·7	52	37	36		46·6	47·3			330	1	r c	0	c c r		10	St C.	240	Trace			Bright cloudy day, slight showers

Image shows a climatological report from Reading University in 1935, showing many similarities to Hooke's original scheme. (Met Office Archives)

Unfortunately for Hooke, he never saw the realisation of this idea and it was nearly 200 years before such national and international networks came into being in the middle of the 19th century, at around the time the Met Office itself was established. However, the climatologists of today remain hugely thankful to Hooke and his contemporaries' pioneering work and the work of all those that followed, which heralded in the era of instrumental measurements of the weather. Their work has meant that we have been able to construct instrumental climate records spanning over 350 years for the UK, and global records spanning over 150 years.

Image: Measuring the weather in Seathwaite, Cumbria 1899 (Met Office Archives)

Data digitisation

All of these meteorological measurements have been made over centuries by a huge army of observers across all walks of life. Many of these people may not have been aware that every one of their observations would be so valuable hundreds of years later. Thankfully for science, many of the original documents have been carefully looked after by archivists, including at the Met Office. The digital age is relatively new in comparison and turning centuries of handwritten weather records into data that can be used by a computer is no small feat.

Data recovery projects are a valuable contribution to modern climate science, releasing data from paper archives and making them available to modern analysis. The sources are varied, from arctic explorations to early weather observers. A recent project led by Professor Ed Hawkins at the University of Reading in collaboration with Met Office, asked the public to help digitise over five million historical UK rainfall observations dating between 1677 and 1960. The project launched at the start of the first COVID-19 lockdown in the UK, and the response from the public was incredible, completing the whole activity in just 16 days. The resulting data has already re-written some of our climate history books, with 1855 now holding the title of driest year on record.

The granularity of the data also means we can explore some regional extremes. For example, Cumbria experienced two exceptionally wet months in November 2009 and December 2015. Thanks to the years of data, we can now put this into an even longer historical context to see that the only other month to come close in over 180 years was November 1852 – an exceptionally wet month for England, during which flooding disrupted the Duke of Wellingtons' funeral procession.

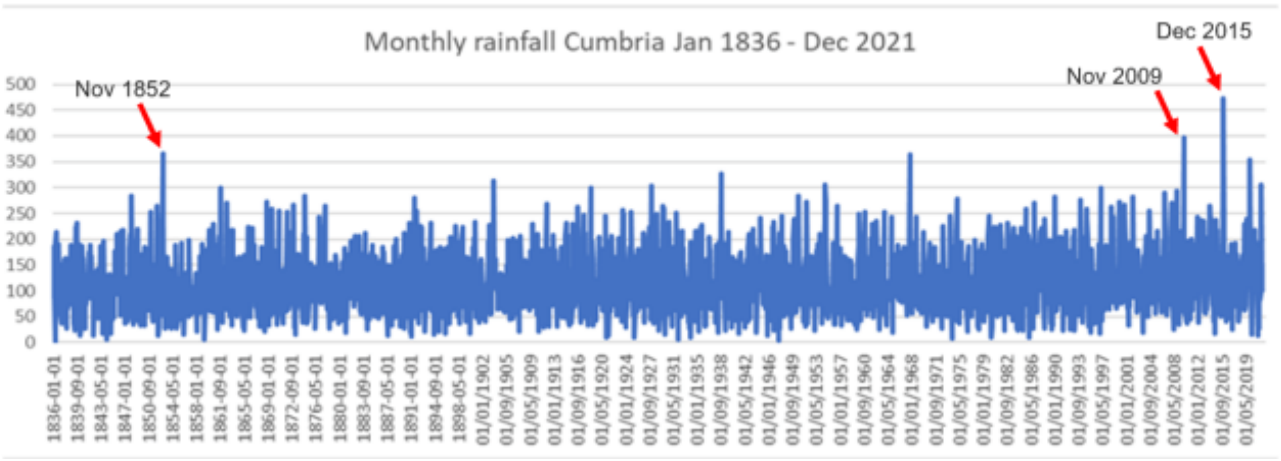


Image: Monthly rainfall for Cumbria 1836-2021 highlighting the extreme wet months in 1852, 2009 and 2015. (Source: Met Office)

The same is true for heatwaves, with the existence of climate records spanning in some cases well in excess of 100 years, allowing us to capture the most extreme heat events from the past. The recovery of historical measurements has allowed us to place over 100 years of summer heatwaves into context. While the heatwaves of 1976 and 1995 are still in living memory, thanks to our climate archives we also know that the summer of 1911 saw a stand-out heatwave. The temperature reached 36.7°C on 9 August that year, a UK high temperature record that stood for nearly 80 years until 37.1°C was reached on 3 August 1990. That temperature has been met or exceeded another four times since this date.

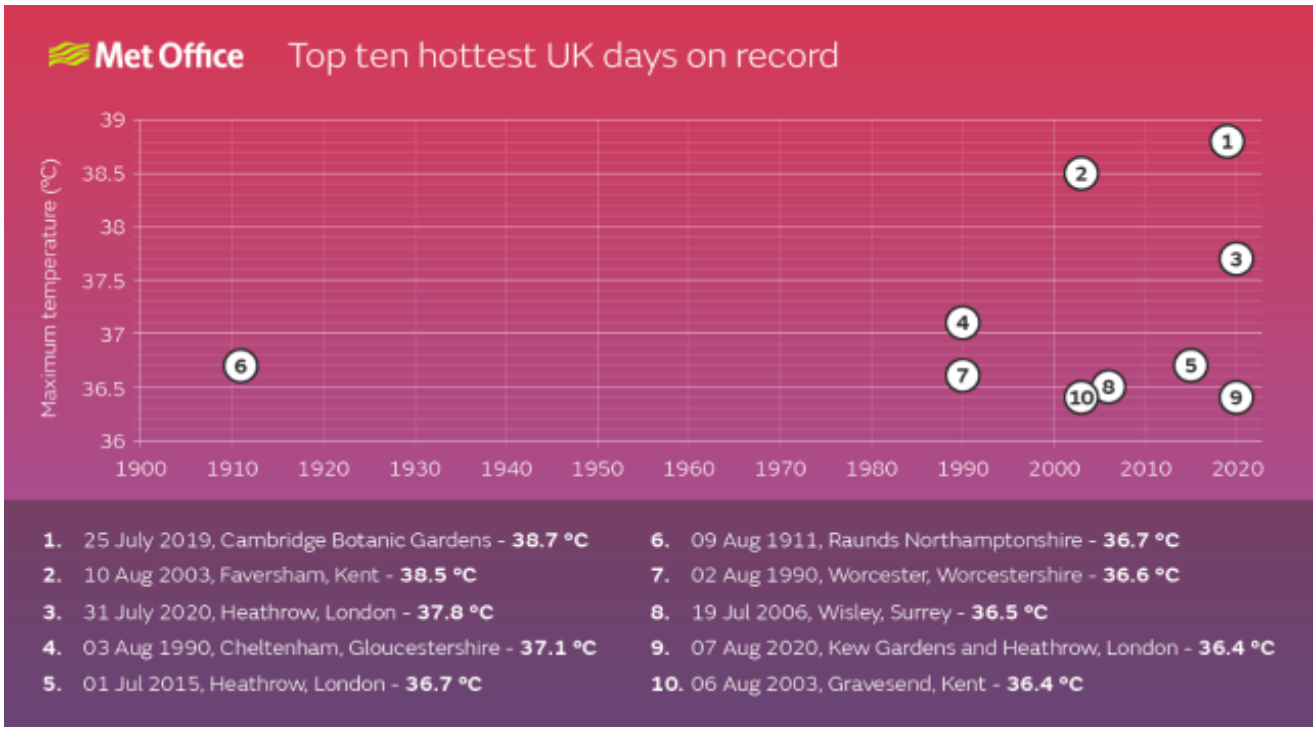


Image: Top ten hottest days on record based on highest maximum temperature. (source: Met Office)

Understanding our climate

Climate change is a global issue, and therefore it is also imperative that we are able to monitor changes across the world. Major national and international collaborations have collated international observations data from land, ice and oceans to track the world's changing climate. These datasets not only broaden our understanding of climate change, but also our chances of achieving global aims such as the Paris Agreement "to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius."

Huge progress has been made in building global temperature datasets covering the mid-19th century onward, so we can say that the 2021 was over 1°C warmer than a pre-industrial baseline. Climate monitoring is, however, not limited to temperature and rainfall. A wide range of essential climate variables covering land, oceans, atmosphere and the cryosphere are routinely monitored. In all cases, digitisation and further data recovery activities continue to improve our understanding of the climate of the past, which in turn helps us understand the risks from the present and future climate change.

Date Created
July 2022

Summer 2022: a historic season for northern hemisphere heatwaves

Description

Today [Tuesday 19 July 2022] has been a momentous day for the UK's climate. Professor Stephen Belcher – Met Office Chief Scientist – and Prof Paul Davies – Met Office Chief Meteorologist – put the UK's and European heatwave into a global context.

Five weather stations from London to Lincolnshire have reached 40^{o}C or more, with Coningsby in Lincolnshire topping out at 40.3^{o}C.

In what has been an historic day, over 30 weather stations have exceeded the previous record of 38.7^{o} C set at Cambridge University Botanic Gardens in July 2019.

Following the first red warning for extreme heat – first announced last Friday – just before 1pm today, provisional data showed that Heathrow airport was the first station to breach 40^{o}C.

Nights were also exceptionally warm, especially in urban areas – with records being broken overnight with 25.8^{o}C being recorded at Kenley in Surrey overnight, creating a provisional new maximum night-time temperature record.

Looking across the northern hemisphere, the UK is not alone in experiencing exceptionally high temperatures. Western Europe has recently seen similar heatwaves grip countries including Portugal, Spain and France.

Further east, China has endured three heatwaves so far this summer, breaking temperature records across the country. The US has also experienced exceptionally high temperatures so far this summer, particularly in the South-West.

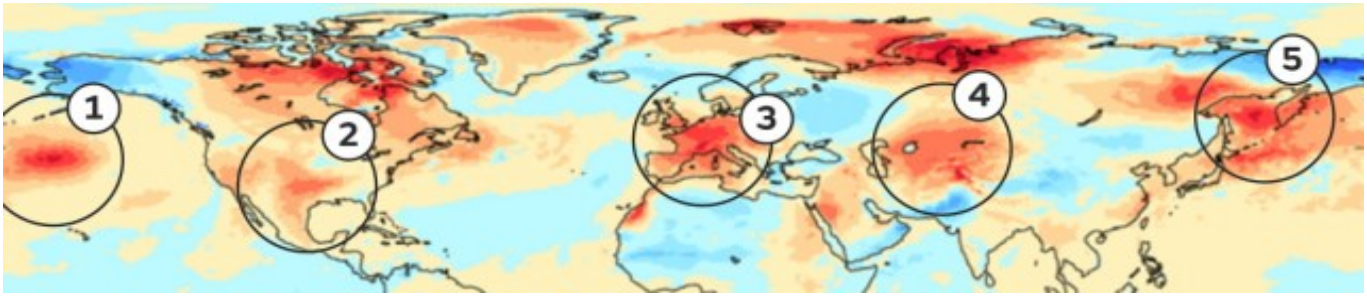


Figure 1: The wavenumber 5 pattern in surface temperature. The colours show the different from average of the near surface temperature for the week commencing 18th July. This graphic has been adapted from the Met Office long-range forecast system: GloSea.

Many of these events are connected by a naturally-occurring pattern in the atmosphere: a so-called *wavenumber 5 pattern*, which is illustrated in Figure 1, showing a map of the difference in surface temperature from their average values, which shows a wave-like pattern around the Northern Hemisphere with a series of warmer regions, circling the globe due to a chain of five high-pressure regions.

This pattern often accompanies heatwaves in the mid-latitudes and is the reason we are seeing concurrent heat waves around the world at the moment. The wavenumber 5 pattern has been studied by scientists for some time now, and at the Met Office we are watching this wavenumber 5 pattern very closely to monitor if the pattern will persist into August.

What of the role of climate change? The extreme temperatures that we have been experiencing in the UK are unprecedented in recorded history. In a climate unaffected by human influence, climate modelling shows that it is virtually impossible for temperatures in the UK to reach 40°C.

Climate change, driven predominantly by accumulation of greenhouse gases in the atmosphere, has warmed the average climate by more than 1^{o}C. So, when we see atmospheric circulation patterns, such as the wavenumber 5 pattern above, they bring even hotter conditions as these two effects combine.

Added to this there are localised effects that can enhance the heat even further. Part of the heat we are seeing in the UK is driven by localised heating of the ground and near-surface air by energy from sunshine. It has been a dry year over many parts of England. When the sun shines on the ground, dry soils cannot release energy through evaporation of moisture, which means that more of the sun's energy goes into heating the air, further amplifying the temperatures in the UK. Climate scientists call this the *soil moisture feedback*.

These three elements have come together in the UK: the global wavenumber 5 pattern driving high temperatures, in the presence of an already warmed climate due to climate change, further enhanced by the soil moisture feedback. They have made these extreme temperatures of 40 degrees possible, and we are now seeing this possibility being realised.

The searing temperatures in North America last year and the current European heatwave show that records are being shattered. The climate science community is very focussed on establishing where these events fit into our climate modelling and predictions, and continuing research to enhance our understanding of how these elements come together as the climate continues to change.

Under a very high emissions scenario we could see temperatures exceeding 40 degrees as frequently as every three years by the end of the century in the UK. Reducing carbon emissions will help to reduce the frequency, but we will still continue to see some occurrences of temperatures exceeding 40 degrees and the UK will need to adapt to these extreme events.

Date Created

July 2022

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Climate monitoring – gathering marine observations in hard-to-reach locations

Description

Throughout July, we have been exploring the theme of climate monitoring. This is crucial as a means for gathering data which informs our understanding of the current state of our climate and enables us to make predictions about future climate scenarios. There are many different methods of climate monitoring which are used to take measurements and observations of key climate metrics such as temperature, precipitation and sea level rise – to name but a few.

Climate monitoring in its many forms comprises a large part of the work that is undertaken by the Met Office. A lot of focus has been placed in recent weeks on new climate records on land where we all live, but it is also important to measure climatology across the oceans as the engine of atmospheric weather patterns and climate change for our planet. One of the methods that we use to gather observations of air pressure, sea surface temperature and currents over the oceans is to deploy drifting buoys in contribution to the Global Surface Drifting Buoy Array. Drifters are small floats deployed from ships at agreed locations that drift freely with the currents, transmitting real-time, hourly meteorological data back to us via satellite. The Surface Marine Observations Team manage a variety of operational surface marine observing networks both in UK waters and on a global scale to deliver in-situ, real-time observations of meteorological & oceanographic conditions. Here, we speak with Port Met Officer Adam Ryan and Marine Observations Manager Emma Steventon about the work that they do within the team and their recent collaboration with remote explorers, the Turner Twins.

What's the role of the Surface Marine Observations team?

As part of the Surface Marine Observations Team within Technical Services Observations Operations, we are primarily responsible for the collection and management of the Voluntary Observing Ship (VOS) fleet and Drifting Buoy marine observations networks. Managed by the Marine Observations Manager, the team of Port Met Officers (PMOs) are each responsible for a subset of the 250-strong UK VOS fleet, coordinating recruitment to the programme, installation and maintenance of observing equipment and ongoing feedback on performance. Some members of the team also assist with the deployment of drifting buoys as part of the Global Drifter Programme; sourcing suitable VOS ships scheduled to sail to our target area of the ocean (usually the South Atlantic), arranging delivery of floats and agreeing the most optimal deployment locations along their designated shipping route.

Why is this research important and how does it keep people safe?

Surface marine observations are an essential component of the Global Observing System, monitoring the global oceans and providing in-situ validation of satellite data and also the initialisation and verification of forecasts. Marine observations contribute to everything from the issue of the Shipping Forecast & Warnings, which help to keep mariners safe at sea under the SOLAS (Safety of Life at Sea) agreement; providing essential information to the shipping industry on vessel & port design, build and efficiency; town planning to future-proof coastal populations against flooding and coastal erosion; and of course specific marine forecasts to advise the UK general public on weather conditions at the beach, essential for knowing whether to pack your surf board!

In the particular case of drifting buoys, hourly measurements of sea-level pressure and sea surface temperature are undertaken. Air pressure data is an element of vital importance to forecasts. Surface marine observations are often the only source of pressure information over the ocean at any given time, as pressure cannot be inferred by satellites. Sea Surface Temperature (SST) is a Global Climate Observing System (GCOS) Essential Climate Variable (ECV), a vital component of the climate system, controlling the atmospheric response to the ocean at both weather and climate timescales.

How do you demonstrate innovation in your work?

As a team, we are constantly innovating and looking to improve and optimise the way we collect marine observations. Most ships sail along standard shipping lanes (for example across the north

Atlantic between the UK and USA, and across the north Pacific between the USA and Asia), so we are always on the lookout for new ways to get observations from hard to reach, data sparse areas of the ocean – in particular, polar regions. This can bring great opportunities to work with the general public, research groups and citizen scientists who are keen to support our mission to source high-quality marine observations. In fact, we were recently approached by a very intriguing pair of professional adventurers known as the Turner Twins, who are on a mission to reach the most inaccessible places on Earth.

Can you tell us about the collaboration with the Turner Twins?

Hugo and Ross Turner kindly agreed to deploy a Met Office drifting buoy on route to the most remote point of the Atlantic – the pole of inaccessibility. Interestingly, because drifters typically operate for a few years at a time and send data from the most remote parts of the world, they represent a high relative value to numerical weather modelling per observation, in comparison to other observing networks.

The twins worked on refitting their yacht in Southampton during May and June and the vessel will be 100% emission-free. Furthermore, Hugo and Ross will be conducting a plastic survey to support Plymouth University's International Marine Litter Research Unit and their long-term clean-up strategy for the oceans.

Follow the latest developments on the twin's journey on their social media.

Find out more about marine observations on our website.

Date Created
July 2022

July 2022: a dry run for UK’s future climate?

Description

So far July 2022 has been the driest July in England since 1911. Up to 26 July there has been only 15.8mm of rain averaged across England; this is only 24% of the amount we would expect in an average July.

At this stage in the month we would expect to have seen well over three-quarters of the month’s rain to have already fallen in an average July.

The situation for the UK is a little better. As it stands, July 2022 is still the eighth driest July since 1836. With only 37.7mm of rain having fallen so far it is the driest July since 1984. Scotland has been closer to average in the north and west, but drier conditions have prevailed for south and east Scotland. Overall Scotland (71%), Wales (39%) and Northern Ireland (43%) have been dry, but the most extreme conditions are in East Anglia and southeast England.

As frequently happens there is a contrast between the northwest of the UK, where some regions, in the far north of Scotland, have already reached around average rainfall – and the southeast which are looking extremely dry indeed.

Dry month

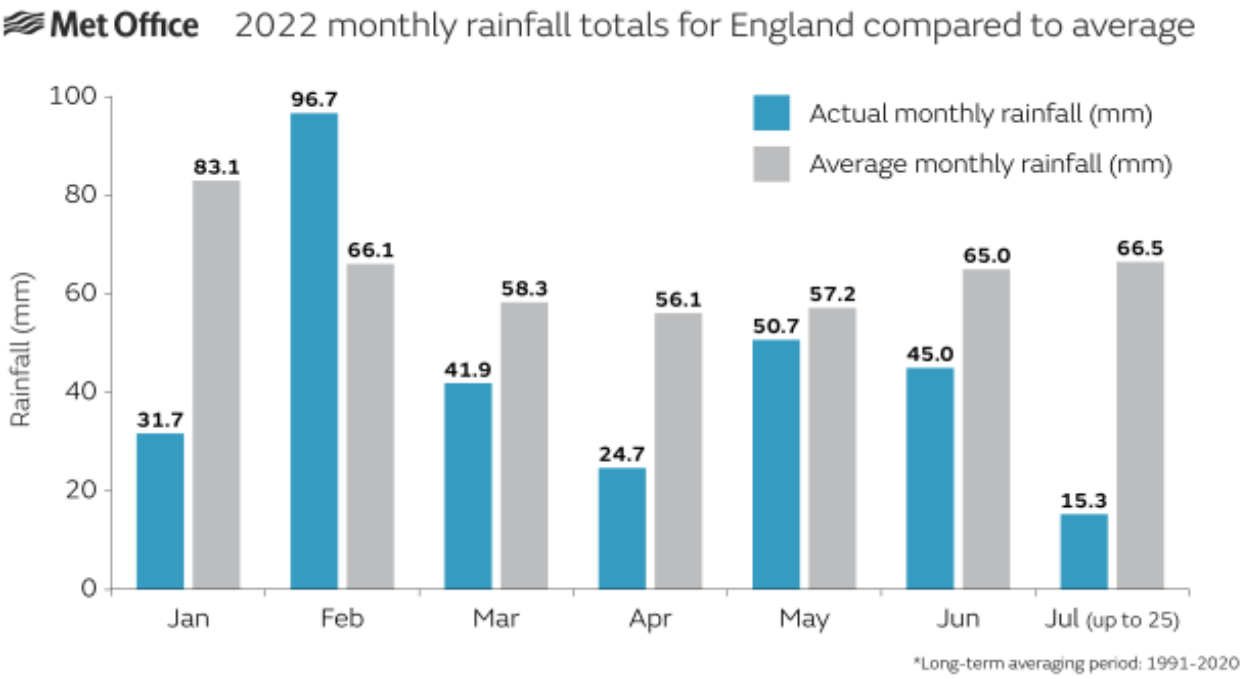
With a little way to run before the end of the month, there is still time for the situation to shift slightly. However, with little significant rain forecast for south and east England, there is scant prospect of a

significant improvement within the next week or two at least. For all July 2022 will be remembered as a dry month and is prompting some in the media to consider the prospect of drought.

Drought isn't within the Met Office's remit; instead, the Environment Agency takes the lead on drought in England, with Natural Resources Wales taking responsibility in Wales; NIEA in Northern Ireland and SEPA in Scotland. There are many factors beyond rainfall, such as water demand and the extent of previous rainfall, that drought planners have to consider.

Mark McCarthy, Head of the Met Office National Climate Information Centre, said: "It is not just July that has been dry. Since the start of the year, all months apart from February have been drier than average in the UK too. The result of this is that the winter, spring and summer of 2022 have all seen less than the UK average seasonal rainfall.

"England has seen the lowest levels during these periods and, rainfall totals for the first six months of the year are around 25% below their long-term average, with the driest regions in the east and southeast."



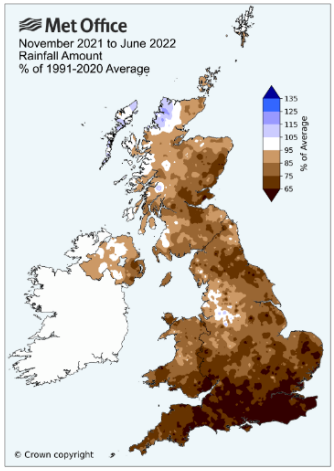
2022 monthly rainfalls for England compared to average

Drier than 1976?

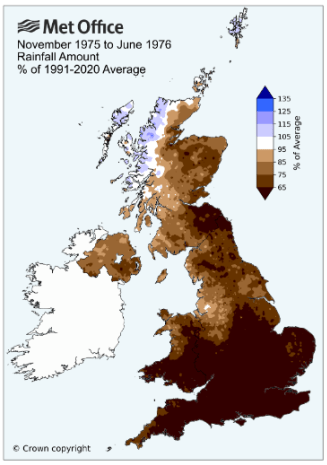
The lack of rainfall through sequential months and seasons becomes significant when looking back over the years as the 8-month period from November 2021 to June 2022 has been the driest in England since 1975/76, with an average of 421mm of rain falling in England, 74% of the 1991-2020 long-term average of 568 mm.

However, the year so far cannot be compared too closely to 1976, as despite the dry trend England had 30% more rain during the first six months of the year than in 1976. Though the statistics do not

necessarily need to be historical to have effects and the Environment Agency has advised ‘There are currently no plans for restrictions on essential water use, we can all do our bit by reducing unnecessary water consumption and following advice from our water company to ensure this remains the case whilst our rivers are exceptionally low.’



Map of rainfall amounts compared to average between November 2021 and June 2022



Map of rainfall amounts compared to average between November 1975 and June 1976

Climate change

Mark McCarthy continued: “Met Office climate change projections highlight an increasing trend towards hotter and drier summers for the UK, with the driest regions anticipated to be in the south and east. While trends in summer temperature and heatwaves are very apparent in the climate records of recent decades, the large variability in our rainfall means that it is too soon to be able to detect the pattern in summer rainfall.”

Persistent high pressure has not only brought a lot of dry weather this month, it has also resulted in a warmer month so far too. Since around the 6th temperatures have generally been above average. Heatwave conditions were experienced around 10th-13th and again from the 16th with an exceptional hot spell during the 18th and 19th July. And so early provisional stats for July show, the average maximum temperature across the UK currently stands at 21.5°C, 2°C higher than the UK average for the month and it currently sits within the top five warmest Julys on record. The current warmest July on record was in 2006 when the average maximum temperature for the UK was 23.3°C.

July’s full provisional weather and climate statistics will be published on 1 August.

Date Created
July 2022

Climate adaptation monitoring – a necessary challenge

Description

In May 2021, we brought scientists, policymakers, community representatives and climate communicators from around the globe together at our virtual Climate Science Conference. Its aim was to set out a vision for how climate science and services can be harnessed in support of the ambitions of diverse societies worldwide to build a more sustainable, more resilient low carbon future. Following robust discussions and valuable insights from speakers and delegates, nine key recommendations were developed, three of which focused on climate monitoring, our climate theme for this month.

As well as highlighting a need to accurately monitor greenhouse gas emissions from different countries, it was also concluded that an integrated monitoring, attribution and prediction system is urgently needed to provide monitoring of extreme weather events and their impacts, and to provide early warning of incremental change and high impact low likelihood events (tipping points). The science behind the development of such a system is the subject of a World Climate Research Programme (WCRP) Lighthouse activity.

Monitoring adaptation

The third recommendation centred around adaptation and the need for measures to be monitored so that their effectiveness can be assessed. Professor Charlotte Watts, Chief Scientific Adviser and Director for Research and Evidence in the Foreign, Commonwealth & Development Office (FCDO), spoke at the conference, saying, “Climate science for adaptation is not just about hypotheses of what futures might look like but it’s about how do we inform real action now to improve lives today and tomorrow.”

Professor Brian O’Neill also spoke in his role as Atmospheric Science & Global Change Manager at the Pacific Northwest National Laboratory. He commented that, “When thinking about our possible futures for climate change risks…we’re going to need to understand how climate change development pathways and adaptation and mitigation responses will interact together to determine the risks we face and the most effective solutions.”

Baroness Brown of Cambridge, Chair of the UK’s Climate Change Committee (CCC) Adaptation Sub-Committee, also referenced the need for mitigation and adaptation to go hand in hand: “Significant adaptation is required to deliver nature-based solutions for achieving Net Zero emissions. We must use nature that will work in the climate in 80 years’ time.”

Around the world, adaptation monitoring is a big gap in the policies of many countries, with monitoring and evaluation of adaptation more difficult to measure than the qualitative data available when considering emissions and mitigation. Brendan Freeman, Senior Analyst, Climate Change Committee, said: “Measurement is fundamental to understanding if adaptation is working. However, current indicators for measuring progress and the effectiveness of adaptation actions are inadequate. There is an urgent need, therefore, for Government to fund work to develop new indicators to support the

comprehensive assessment of adaptation progress.”

Adapting for tomorrow now

In the UK, the Department for Environment, Food and Rural Affairs (Defra) is the lead Government department for domestic climate adaptation. It’s a statutory requirement under the Climate Change Act of 2008 to plan how the UK will adapt to climate change. In 2023, Defra will release the new National Adaptation Programme (NAP), which will highlight the ways that the UK is planning to adapt to climate change in the next five years. The government’s ambition for NAP3 is to have a clear set of objectives for adaptation, and policies, programmes and investments to meet those objectives, with metrics and timelines linked to the 61 risks set out in the third Climate Change Risk Assessment (CCRA3) published in January.

Climate science and services

UK urban park

Effective climate services are an important component in informing climate change adaptation measures. As a climate service provider our role is to translate our leading scientific research into user-driven climate services, enabling users to better understand & manage the risks & opportunities arising from climate variability & change.

One of the outputs from the UK Climate Resilience Programme (UKCRP), funded by the UK Government’s Strategic Priorities Fund, are the city packs. Developed by the Met Office, they use the

latest UK Climate Projections (UCKP18) to provide high-level, non-technical local summaries of a city's future climate. The city packs use graphics and tables to communicate scientific research in an accessible way, providing robust climate information to help city decision makers at local and city councils plan for the future, enabling our towns and cities to become more resilient to climate change.

In Manchester, one of the risks facing the city is flooding, due to the warmer, wetter winters that we expect to experience in the future. Following our work with Manchester City Council, they're working on adaptation measures which provide co-benefits in local communities. For example, nature-based solutions are a key element used within a park in the West Gorton community area in Greater Manchester. Permeable paving and vegetation reduce flooding and storm water run-off and act as a cool area in heatwaves, helping with multiple impacts of climate change. The park has multiple uses for the community including for sport and recreation, improving wellbeing and benefitting local biodiversity and air quality.

Dr Rosie Oakes, Met Office Climate Scientist, commented recently in the Mostly Climate podcast, *"When you think about climate change, it can be so scary and overwhelming. But as soon as you envisage a future world which is actually better than the one you live in right now because of the adaptation that you put in place, it makes me feel more hopeful at least."*

Date Created
July 2022

Climate study backs up Met Office research

Description

A study published today [Friday 29 July] by World Weather Attribution supports a previous Met Office study that was published before this summer and which looked at the prospect of 40°C in the UK.

The UK's temperature record was broken on 19 July 2022 when 40.3C was recorded at Coningsby in Lincolnshire. Picture: Shutterstock

The Met Office study found that the likelihood of seeing 40°C in the UK has been rapidly increasing and what would once have been an extremely unlikely event without climate change has now become a distinct possibility. Both the Met Office and WWA studies found that human-caused climate change has made the chance of 40°C in the UK about ten times more likely when compared with the pre-industrial climate. Taken together, the Met Office research carried out ahead of this summer's heatwave and the WWA study conducted shortly afterwards, this research underscores the importance of needing to adapt to such extreme temperatures.

While current calculations indicate that the chance of 40°C temperatures occurring in the UK is around a 1% chance every year, Met Office research shows that this could increase with further greenhouse gas emissions. In the most extreme emissions case considered this could reach around 33% chance every year but current international efforts to reduce greenhouse gas emissions may reduce this to 5-

6% in any given year. Further emission reductions inline with the Paris agreement (CoP26) climate temperature goals could reduce the yearly chance further.

The Met Office study was published in 2020 in a paper by Nikos Christidis, Mark McCarthy and Peter Stott in Nature Communications. At the time, Nikos Christidis said: “Our paper shows that the likelihood of hitting 40°C is rapidly increasing. In a ‘natural’ climate without human-caused climate change, the event would have been exceptionally rare.”

It is clear that temperature extremes of 40°C or more have been unlikely in the historic climate and are still unlikely today. Different studies show some variation but all agree that events of this magnitude are unlikely in the current UK climate but that the chances are growing all the time

Professor Jason Lowe OBE said: “The potential for a temperature of 40°C or more for the UK’s current climate is captured within computer models and the output from the UK Climate Projections (UKCP18).”

It is not inconceivable that we could get another forecast of 40°C for the UK later this summer. Professor Peter Stott – a globally recognised authority on heatwaves, added: “The heat which brought these record-breaking temperatures to our shores is still in place in south western Europe, prompting the risk of further extremely hot temperatures.”

The heatwave in the UK fits into a global pattern of weather this summer. As well as the exceptionally high temperatures in Western Europe, China has endured three heatwaves so far this summer and the US has experienced exceptionally high temperatures, particularly in the South-West. This is part of a naturally-occurring wave-like pattern in the atmosphere around the Northern Hemisphere. When combined with a warming climate and localised effects that can enhance the heat even further, the result is a widespread pattern of heatwaves across the planet.

Peter Stott concuded: “These searing temperatures across the globe, not just this year but in the last few years, show how temperature records are not just being broken but are being shattered. The climate science community remains focussed on establishing where these events fit into our climate modelling and predictions, and continuing research to enhance our understanding of how these elements come together as the climate continues to change.”

Date Created
July 2022